

AMENDMENTS TO THE SPECIFICATION – MARKED-UP VERSION

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority from Japanese Patent Application No. 2002-264638 filed on September 10, 2002.

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

[0002] The present invention relates to an apparatus for a pivot assembly used as the bearing of a swing arm type actuator in a hard disk drive, and more particularly to the improvement of the fixing means of a sleeve that maintains the spacing of two ball bearings.

DESCRIPTION OF THE RELATED ART

[0003] ~~As the~~ The above-mentioned kind of pivot assembly, ~~for example,~~ ~~one~~ that fixes ball bearings at both ends of a shaft and, in addition, mates a sleeve to the outer circumference of the ball bearings, and maintains by the bottom wall part of the sleeve a space between both ball bearings is known. This ~~kind of~~ pivot assembly is mated to the base part of a swing arm having a magnetic head on the tip, and is attached by means of a screw passed through the swing arm to a screw hole formed in the sleeve.

[0004] Now, in the above-mentioned conventional pivot assembly the outer ring of the ball bearing and the sleeve were fixed by an adhesive. Because of this, ~~there was the problem~~ arose that gas ~~was~~ would be generated from the adhesive ~~and brought about~~ that would result in a harmful effect on the surface of the hard disk and magnetic head. In order to solve this ~~kind of out gas~~ outgassing problem, even

pressing of the outer ring into a sleeve and fixing was carried out. However, with fixing by pressing in, management of the allowance for pressing in was difficult and there was the problem that the reliability of the fixing of the sleeve was deficient.

[0005] Consequently, the present invention aims to offer a pivot assembly that can reliably and securely fix a sleeve and, in addition, can also solve the problem of ~~out gas~~ outgassing.

SUMMARY OF THE INVENTION

[0006] Accordingly, the present invention is directed to a pivot assembly for hard disk drive use in which ball bearings are mated to both ends ~~parts~~ of a shaft, ~~and to the outer circumference of these ball bearings,~~ an inner wall part extending to the outer circumference of these ball bearings is ~~has~~ mated to a sleeve disposed between both of the ball bearings, and in which the sleeve is fixed by laser welding to the outer ring of the ball bearing.

[0007] In ~~the~~ this pivot assembly for hard disk drive use (hereinafter, called simply, "pivot assembly") of the above-mentioned configuration, because the sleeve is fixed by laser welding to the outer ring, the sleeve can be reliably and securely fixed, and, moreover, the problem of ~~out gas~~ outgassing can be solved.

[0008] There is no limit on the laser source of the laser welding; for example, a YAG laser can be used. Furthermore, laser welding can be carried out ~~across~~ along the entire circumference of the point of contact of the outer ring with the sleeve (seam weld), or can be carried out at multiple places mutually separated along the contact part (spot weld).

[0009] ~~Now, when~~When welding a sleeve to the outer ring of a ball bearing, spot welding cannot be used, because with spot welding by means of electric resistance welding and gas welding, the welding part greatly lowers the bearing precision due to the thermal effect. ~~With~~ In the present invention, because ~~a~~the sleeve is welded to the outer ring by means of laser welding, ~~by narrowing the spot diameter of the laser beam to about 0.4 mm, for example,~~ the weld part can be made smaller by narrowing the spot diameter of the laser beam to, for example, about 0.4 mm. ~~By means of this~~ In this manner, the thermal effect that the weld part imparts to the outer ring is reduced, and a ~~lowering of the~~reduction in bearing precision can be prevented.

[0010] Furthermore, ~~welding of~~ the sleeve and the outer ring can be ~~carried out~~ welded at the boundary of the end face of the outer ring and the inner circumference of the sleeve. However, because it is normal for the outer ring to have a cross-section abbreviated circular arc-shaped chamfer at the intersection of the outer circumference face and end face thereof, a concave part is formed between the edge part of the end face of the outer ring and the sleeve. In this case, the gap becomes smaller toward the inner part of the concave part, and a laser beam must correctly hit the contact part of the sleeve and outer ring positioned in the innermost part thereof. Moreover, the laser beam must irradiate so as to follow the common tangent of the chamfer and the inner circumference of the sleeve, in short, the inner circumference of the sleeve. ~~When these points are taken into consideration, in the event~~ If the laser beam is of a small diameter as mentioned above, when the position of the sleeve fluctuates even slightly, the laser beam cannot irradiate the necessary place, and so laser welding is not easy.

[0011] The present invention, including its features and advantages, will become more apparent from the following detailed description with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] Figure 1 is a side cross-section view that shows the pivot assembly of the first embodiment of the present invention.

[0013] Figure 2 is a cross-section view of II - II of Figure 1.

[0014] Figure 3 is an enlarged side cross-section view of the part indicated by arrow III of Figure 1.

[0015] Figure 4 is a side cross-section view that shows the pivot assembly of the second embodiment of the present invention.

[0016] Figure 5 is a cross-section view of the V - V line of Figure 4.

[0017] Figure 6 is an enlarged side cross-section view of the part indicated by arrow VI of Figure 4.

DETAILED DESCRIPTION

[0018] ~~Accordingly, in~~ In one mode of the present invention, ~~forming a~~ concave part that reaches up to the vicinity of the outer circumference of the outer ring is formed, and ~~laser welding the bottom wall of this concave part~~ is laser welded to the outer circumference of the outer ring ~~is regarded as a suitable mode~~. With this kind of mode, if the laser beam is irradiated to any place on the bottom wall of the concave part, laser welding is carried out. Consequently, since the irradiation angle and the irradiation position of the laser beam do not need to be strictly controlled, laser welding

can be easily carried out. However, in order to cause the bottom wall to be welded by a laser beam narrowed as mentioned above, it is desirable that its thickness be 0.3 mm or less. Here, the concave part can be made as a groove that extends along the entire circumference of the sleeve. In this case, welding that extends along the entire circumference of the groove can be done, or spot welding at multiple places mutually separated along the circumferential direction can be done. Furthermore, in the case of forming a sleeve, in order to ensure the strength of the sleeve, it is desirable that the thickness of the bottom wall be 0.1 mm or more. It is even acceptable if in the concave part ~~is~~ holes are provided mutually separated in the circumferential direction of the sleeve, and spot welding at one or two or more places of the bottom walls of those holes can also be done.

[0019] ~~As~~in another mode to make laser welding easy, holes are formed on the outer circumference of a sleeve, ~~forming holes~~ linked to the outer circumference of the outer ring, and ~~laser welding~~ the edge part of these holes are laser welded to the outer circumference of the outer ring, ~~can also be done~~. In this case also, since laser welding can be carried out if a laser beam is irradiated to any place of the edge part of the hole, and since strict control of the irradiation angle and irradiation position of the laser beam is not necessary, laser welding can be easily carried out. Furthermore, with this kind of mode, there is also the advantage that, different from the case of forming the ~~holes~~groove, the strength of the sleeve, practically, does not decrease.

[0020] Carrying out the above-mentioned kind of laser welding at places separated in the axial direction from the rolling groove of the outer ring is desirable. By

this means, the thermal effect on the rolling groove and balls due to the laser welding can be reduced, and the bearing precision can be improved.

[0021] The first embodiment of the present invention will be explained with reference to Figure 1 ~ Figure 3. Reference numeral 1 in these figures is a shaft. A hole 11 is formed in the center of the shaft 1 and, by means of a shaft passed through this hole 11; a pivot assembly is attached to a hard disk drive. A flange 12 is formed at the lower end part of the shaft 1. On the outer circumference of the shaft 1, the ball bearing 2 caused to contact the end face is caused to mate with the flange 12.

[0022] A ball bearing 2 is provided with an inner ring 21 and an outer ring 22 and multiple balls 23 which can move by rolling in a circumferential direction between them. The balls 23 are maintained at regular intervals in a circumferential direction by means of a retainer that is not illustrated. The opening part between the inner ring 21 and the outer ring 22 is blocked by a seal 25. Furthermore, reference numeral 26 in the figures is a snap ring to fix the seal 25.

[0023] A ball bearing 2 the same as mentioned above is caused to mate with the upper end part of the shaft 1. Also, a sleeve 3 is caused to mate with the outer circumference of these two ball bearings 2. The sleeve 3 forms a cylindrical shape, and in the center part in the axial direction thereof, a spacer part (inner wall part) 31 with an inner diameter smaller than both end parts is formed. At both end faces of the spacer part 31, the outer rings 22 of ball bearings 2 make contact, and by means of this, the outer rings 22 are separated from each other by a fixed interval. Furthermore, on the outer circumference of both end parts of the sleeve 3, a groove (concave part) 32 that reaches to the vicinity of the outer circumference of the outer rings 22 is formed along

the entire circumference. The center of the bottom wall 33 of the groove 32 is caused to correspond to the end face of the outer ring 22. And, the center of the bottom wall 33 is laser welded to the edge part of the outer ring 22 at multiple places separated at regular intervals in the circumferential direction, and, by means of this, the sleeve 3 is fixed to the outer ring 22. Reference numeral P in Figure 2 indicates the nugget due to welding. Furthermore, seam welding along the entire circumference of the center of the bottom wall 33 is also possible.

[0024] To the outer circumference of a pivot assembly of the above-mentioned configuration the base of a swing arm provided with a magnetic head on the tip is attached. In the base of the swing arm, a hole that mates the pivot assembly is formed, and a screw passed through the above-mentioned base is screwed in a screw hole (omitted from the figure) formed in the sleeve 3.

[0025] In a pivot assembly of the above-mentioned constitution, because the sleeve 3 is fixed by laser welding to the outer ring 22, the sleeve can be reliably and securely fixed, moreover, the problem of ~~out-gas~~ outgassing can be solved.

[0026] In particular, in the above-mentioned first embodiment, in the outer circumference of the sleeve 3, a groove 32 that reaches up to the vicinity of the outer circumference of the outer ring 22 is formed, and because the bottom wall 33 of this groove 32 is laser welded to the outer circumference of the outer ring 22, strictly controlling the irradiation angle and irradiation position of the laser beam is not necessary; thus, laser welding can be easily carried out. Furthermore, since the laser welding is carried out at a place furthest separated from the rolling groove of the ball

bearing 2, there is no thermal effect with respect the rolling groove and balls 23, and bearing precision can be improved.

[0027] Next, the second embodiment of the present invention will be explained with reference to Figure 4 ~ Figure 6. The second embodiment differs from the first embodiment on the point that a hole 35 was formed, instead of the groove 32 of the first embodiment. Accordingly, in the following explanation, the same reference numerals were given to the constituent elements that are the same as those of the above-mentioned first embodiment and the explanation thereof is omitted.

[0028] As shown in the figure, on the outer circumference of both end parts of the sleeve 3, multiple holes (concave part) 35 are formed at regular intervals in a circumferential direction. The tip of the hole 35 forms a tapered shape[d], and at this tip, an opening 36 that links to the outer circumference of the outer ring 22 is formed. The opening 36 is positioned in a place that approaches the ball 23 side from the end face of the outer ring 22. And, the edge part of the opening 36 is laser welded to the outer circumference of the outer ring 22 at one place or the entire circumference thereof, and by means of this, the sleeve 3 is fixed to the outer ring 22.

[0029] In the second embodiment, the action and effect equal to that of the above-mentioned first embodiment can also be obtained. Particularly, in the second embodiment, there is the advantage that there is essentially no decrease in the strength of the sleeve 3, compared to the case of forming a groove 32, as in the first embodiment, because a hole 35 that links to the outer circumference of the outer ring 22 is formed.

[0030] According to the present invention as explained above, because a sleeve is fixed by laser welding to the outer ring of a ball bearing, the sleeve can be reliably and securely fixed[,]; moreover, the problem of ~~out-gas~~outgassing can be solved and the like effects can be obtained.

[0031] In the foregoing description, the apparatus and method of the present invention have been described with reference to specific examples. It is to be understood and expected that variations in the principles of the apparatus and method herein disclosed may be made by one skilled in the art and it is intended that such modifications, changes, and substitutions are to be included within the scope of the present invention as set forth in the appended claims. The specification and drawings are accordingly to be regarded in an illustrative rather than in a restrictive sense.

REMARKS

Claims 1, 2, and 4-6 and the Specification have been amended in response to the Office Action of February 23, 2005. Claims 1-6 are pending in this application. No new matter has been added.

Objections to the Specification

The Examiner objected to the Specification because "the entire disclosure, specification and claims, do not conform with idiomatic English." In response, the Applicants have amended the Specification in order to comport with idiomatic English and the requirements of 37 C.F.R. 1.52(a) and (b). In doing so, the Applicants have added no new matter. Please replace the original specification with the substitute specification attached herein at the end. The Applicants therefore request that the objections to the Specification be withdrawn.

Claim Rejection Under § 112

The Examiner rejected Claims 1-6 under 35 U.S.C. § 112, second paragraph, for being indefinite, in that "the claims do not conform with idiomatic English to the extent where it is unclear what is being claimed." In response, the applicants have amended Claims 1, 2, and 4-6 to better comport with idiomatic English. The Applicants maintain that Claim 3, when read in conjunction with amended Claims 1 and 2, comports with idiomatic English.

In addition, the Examiner noted that in Claims 1, 2 and 6 certain claim features either had no antecedent basis or were not positively recited. These claim elements were: "ball bearings," "shaft," "inner wall part," "sleeve," "outer rings," "bottom wall," and "rolling groover."

In response with regard to Claim 1, the Applicants have amended Claim 1 to recite "ball bearings, each comprising an outer ring." Thus, the elements "ball bearings" and "outer rings" are now positively recited. The applicants have also positively recited "a shaft" in amended Claim 1. The applicants have positively recited "inner wall part" in Claim 1. Lastly, the applicants have amended Claim 1 to recite "a sleeve, disposed between both of said ball bearings." Thus, the elements of a "shaft," "inner wall part," and "sleeve," are positively recited.

In response with regard to Claim 2, the applicants have amended Claim 2 to recite "a concave part that opens on the outer circumference of said sleeve and which comprises a bottom wall in the vicinity of the outer circumference of said outer ring." The "bottom wall" is thus positively recited.

In response with regard to Claim 6, the Applicants have amended Claim 6 to recite that the "apparatus of Claim 5, further comprising a rolling groove in the outer ring of the ball bearing." Thus, "rolling groove" is positively recited in Claim 6.

Lastly, the Examiner stated that "an inner wall part . . . bearings" in Claim 1 is indefinite, that "reaches up to the vicinity of the outer circumference" in Claim 2 is indefinite, that the phrase "hole linked to . . . formed" in Claim 5 is indefinite, and that the element "places separated . . . ring" in Claim 6 is indefinite.

In response with regard to Claim 1, the Applicants have amended Claim 1 to state that the inner wall part is mounted on the shaft and extends to the outer circumference of the ball bearings. Further, it is shown in amended Claim 1 that the sleeve is mated to this inner wall part. Thus, this structural element is definitely claimed.

In response with regard to Claim 2, the Applicants have amended Claim 2 to recite "a concave part that opens on the outer circumference of said sleeve and which comprises

a bottom wall in the vicinity of the outer circumference of said outer ring." Thus, the beginning and end point of the concave part are clearly defined in amended Claim 2.

In response with regard to Claim 5, the Applicants have amended Claim 5 to recite "a hole extending from the outer circumference of said sleeve to the outer circumference of said outer ring" Thus, the location and depth of the hole element of amended Claim 5 is now clearly defined.

In response with regard to Claim 6, the Applicants have amended Claim 6 to recite "places on the outer ring separated in the axial direction from the rolling groove of said outer ring." This amendment, in conjunction with the amendment positively reciting the "rolling groove," clearly defines this structural element by clearly defining the location of the laser welds.

Accordingly, the Applicants believe that the amendments to Claims 1, 2, and 4-6 put the claims in condition for allowance. An early action on the merits of Claims 1-6 is requested.

Conclusion

The Patent & Trademark Office is authorized to charge any fees required for the entry of this Response, including fees for an extension of time, and any further fees that are properly assessable in this case, or to credit any overpayment, to Deposit Account No. 500675, Order No. 051319/0057. In the event that an extension of time is needed for entry of this Response that is not otherwise provided for, such extension of time is hereby respectfully requested.

Lastly, Applicant notes that the references cited in an Information Disclosure Statement (IDS) and PTO Form 1449 submitted by Applicant in June 2004 before the mailing

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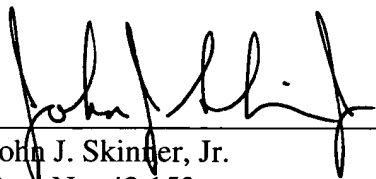
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date of the first Office Action have not been considered. Applicant hereby requests that the

Examiner consider such in any further examination on the merits. A copy of the IDS and PTO

Form are enclosed again. No fee is believed to be due.

Respectfully submitted,

A handwritten signature in black ink, appearing to read "John J. Skinner, Jr.", written over a horizontal line.

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Date: May 23, 2005

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